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An Inaugural Essay—

On the

Erectile Tissue

For the Degree of Doctor of Medicine

In the

University of Pennsylvania

By Joseph Pancoast

of New Jersey—

February 23^d 1827.

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Erectile Tissue

Erectile, derived from the Latin *erigere*, to erect, or to stiffen, has been proposed by, Mr. M. DePuytren & Kuller, as the name of the tissue, of which I am about to treat. Though important & interesting, in its functions & phenomena, it has until within a recent period, been little understood by Anatomists. The proposition has long known, that many parts of the animal economy, manifest in the exercise of their functions, a faculty of vital expansion, directly at variance with the contractility which constitutes the peculiar mode of action of every other part. This active dilatation or extension is accompanied by an increased afflux of Blood through the arteries, which produces an instinctive turgescence of the tissue with a manifest increase in its volume. Under this name are enumerated the following parts, which are extremely analogous in function & in structure, as far as our gross senses are permitted to investigate the delicate formation which some ^{of them} possess. They exhibit the characteristic phenomena of this tissue, in the exercise of their respective offices. The Corpora, cavernosa and

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Spongiosum Penis, The Clitoris, The internal face of the
Vulva and Vagina, in their common erections; The
mammary Papillae, during the excretion of milk; The
Iris, in its common office in vision; The Papillae of
Touch & Taste, in their respective actions; The Intestinal
Villi in their function of absorption: The Fallopian
Tubes, in their erection in coitus, to grasp the ova
when they have burst their follicular enclosures; The
Tissue of the Lips when under excitement; The Spleen;
and several adventitious formations, as that form of
"Nevi Martini," called Arterioles from Anastomosis by
Mr. Bell: Various Polypi &c. &c. These parts,
resemble each other also, in their causes of excitation, in
the temporary duration of their erection, and the pro-
duction of pleasurable emotions, which have been thought
by some their diagnostic distinctions, and in the greater
degree of readiness with which they respond to the action
of indirect, than direct Stimuli. Thus we see erections
to occur in the Penis, Clitoris &c. through the influence
of the Imagination, which mechanical irritation might be
insufficient to excite. The Iris, contracts or dilates itself

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according to the presence or absence of rays of light upon the Retina, which has passed by its own surface without producing any effect: And the gustatory Papillae erect themselves with vigour, when the olfactory organs are regaled with the smells of Mandarins, which the stomach desiderates. Bartholin who first treated of this active dilatation, associated with it, the expansive movement of the heart, and a peculiar tissue which he supposed to exist in the skin, and to cause the phenomena of blushing & that happy glow over the surface of the body, which is felt in a pleasing emotion. Also certain Zoophytes & some Microscopical insects which undergo a dilatation when exposed to the action of heat & humidity: And the swelling of the anterior part of the neck, during the prevalence of passion, and some of the hysterical affections.

This last fee under the observations of the ancients, & that part of the neck received from them, the appropriate title of "Πελοπιδνα", from "Πελοπιδνα" to inflate.

The Penis by conventional agreement has been assumed as the type of the "Erectile Tissue", which exists within its structure in its greatest proportions.

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This organ is composed of two bodies the *Corpus cavernosum* & *Corpus spongiosum*, bound by a modified extension of the common integuments of the body. These bodies essentially composed of the spongy tissue, determine by the degree of their erection the circumference & length of this organ. The cavernous body arising by two *Crura* from the ascending *rami Ischioorum*, separated by the suspensory ligament of the *Penis*, quickly unite to form one body which has on its inferior side a groove for the body of the *urethra*. Its anterior portion is obliquely united into a cavity in the *Glans Penis*. When the *crura* unite there is a continuation of the fascia above, which gives the body when stripped of its investing membrane the appearance of two *crura* laying side by side. As it proceeds downwards it is divided into parallel & vertical incisions, so as to permit the freest communication between the sides, & to entitle itself to the name of *Septum Fectiforme*. This body is enveloped with a fibrous, white, & elastic sheath, which sends from its internal surface, little blades, or prolongations, between which is placed, a tough, deeply-red, gelatiniform sub.

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stance, through which the minute vessels ramify innumerable. This description is drawn from the massive organs of two geldings which I examined, & there is no doubt, but in the unemasculated horse, the vessels would have been still better developed. The sheath is pierced with holes for the passage of vessels & particularly well, where it is in contact with the spongy body. The principal arteries come from the internal pudic, & divide into two branches, the Dorsales & the Cavernosae. The first runs as its name indicates, and terminates at the Glans Penis. The cavernosae pass on each side into the cavernous body, under the Symphysis Pubis, and exhaust themselves in fine ramifications. The veins arise by small branches & unite themselves mostly into one trunk in the human Penis, the Venae Dorsales. In the horse I have found four or five, of the size of a finger, forming a plexus, in which the whole organ seemed completely enveloped. The nerves in their number & magnitude, are perfectly in relation with the sensibility of the part. They come from the sacral plexus. Upon the particular nature of the tissue, containing within the fibrous involucre, Anatomists have variously differed,

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Visalius, in his work "De corporis humani fabrica,"
lib. X. cap. XIV. speaks of it in these words. "corpora
haec (cavernosa) enata, ad eum finem modum, ac si,
ex innumeris arteriarum, venarumque fasciculis,
quam tenuissimis, simulque proxime implicatis, utia
quoddam efformarentur, obviolum a nerva illa mem.
branaeque substantia comprehensa." Malpighi appears
to have made an observation less correct. He says:
"Sinuum speciem in mammarum tubulis, et in fere
habemus: In his nonnihil sanguinis, reperitur, ita
ut videantur venarum diverticuli, vel saltem ipsarum
appenices." Keyser, Haller, & even Bichat himself,
considered this tissue of a loose elastic cellular nature,
forming cells at the terminations of the arteries, into which
during section the blood was poured, & afterwards ab-
sorbed & carried away by the veins. These great Physiologists
tho' been so grossly deceived, must have drawn their opinions
from organs, drawn, after the common cellular figure of the
part had been inflated, the blood vessels effaced, and their
gelatiniform mucus evaporated. In this state it seems
to present an appearance such as they describe.

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Cuvier. Ribes, in France, Mascagni, Farnesi and
Moreschi in Italy, & Keideman a German have shown by
injections of the arteries & veins, that there are no cells or
spongiform structure in the erectile tissue, but that it
consists of minutely divided arteries & debatable venous
ramuscles, interwoven in the manner of capillary nets.

Mr Hunter remarked, the spongy bodies of the penis
were not cellular, but consisted in a plexus of veins, visible
in the human subject, but still more so in the horse & other
large animals.

Cuvier states, the cavernous body in
the Elephant penis, is essentially composed of minutely
divided veins, communicating with each other ad infinitum
so that in a transverse section of the body, nothing could be
seen but holes & meshes, and that the spaces which the
vessels left among themselves were more contracted than
their own orifices. The transverse fibula, & the septum
flectiformes seem destined mainly to afford points of
support to the ramifying vessels: They may also assist
the ligamentous coat in opposing a dilatation beyond a
certain extent,
thus preventing a varicose enlargement of the veins, which
might otherwise ensue. The portion of the urethra alba

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called spongy, commences with an oval enlargement of the side of a nut, the bulb, & terminates in an expansion at the end of the penis, called the Glans, having its intermediate substance, much reduced in size, though its body throughout is analogous in structure. It is surrounded with a fibrous envelope, & between it, and the mucous canal within, repose the ramified Blood vessels. It is composed of a tissue precisely analogous with that of the cavernous body, & partakes with it in common its erection, tho' the former sometimes it is said been seen separate. The Glans appears to be more delicate in its structure, richer in blood vessels and more sensible in its functions: It has been found in some instances, isolated by a septum. The erection of this structure is never so firm & unyielding as that of the body of the penis, which may perhaps be accounted for by its perforation; so remedy this which might interfere with its functions it is placed in the center of that body to be assisted by its firmer erection. There is a diminution of this canal during an erection, which has been quoted by some as a ^{proof} ~~testimony~~ of its muscularity: It is but a consequence of the erection of the spongy body, and may be pro-

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duced by an injection. From the concurrence of the several anatomists above, & from my own observations I am certain that the Corpus Spongiosum & Cavernosum, are entirely destitute of spongy or cavernous structure, I should be called by terms, which would convey more adequate ideas of their structure. In the minutely divided arteries & dilatable veins then, the Phenomena of erection are produced, which it becomes me, now to consider. That the principal use of this vascular tissue in the penis is to produce its erection, is very evident for in the Bear, the Otter, the Badger, the Fox, its partial absence is supplied by a substitution of Bone. Upon the manner in which this Phenomenon is produced, the world has long has been divided: Of the theory which accounted for it by the contraction of the muscles of the Penis the subsequent contractions of the veins against the lymphatics I shall only advert to speak of its insufficiency. The attachment of the muscles in the first place, is unfavourable to perform completely such an office, & on the second, they are endowed with cerebral nerves and should act in obedience to the will: The con-

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uses of which, is well known to be the case: Their office is evidently, to assist in the more common functions of the Penis: The constriction of the veins can be artificially produced, without compressing the arteries, yet erection will not be the result. Besides in the Papillae of the breast, and in the Iris, we have true & genuine erection, where there are neither muscles to elevate, nor bones to constrict. Of another which presumes an extravasation of Blood & spirits into the Spongy cells I need say less: As these cells have been proved to have no existence save in the Imagination.

Besides the disappearance of an erection is sometimes too sudden, to permit us to presume that the veins could have removed such a quantity of Blood so soon, by absorption. Moneschi having his attention accidentally directed to the cuticular body - has fairly proved, that it is essentially composed of vascular tissue: But at the same time he asserts to deny, that the cavernous body is anything more than tenacious cellular tissue, so circumstanced that the most delicate matter of injection can pass but a short distance into its cells, & containing

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but a scanty proportion of blood vessels. This
apportionment astonishes the more, as the most superficial
observation in the horse, is sufficient indubitably to
contravert it. In the excision of this organ from the
horse, I have seen at least a pint of venous blood
discharged by a cut into the veins. Soemmerring &
De Boer assert that they cut the penis of a dog,
during its erection & saw the organ regain its former
size & flaccidity, in proportion as the blood escaped from
it. Monro has besides, failed to account for the
erection of the cavernous body. In what does the
phenomena of erection consist? All admit it to
be produced by the collection of blood in the interior
structure of the organ; induced by an increased afflux
through the arteries, or by a constriction of the veins,
or by both causes acting at the same time. Cuvier,
who presumes that tumescence takes place in the di-
lata venous radicles, supposes it to be produced, by
a spasm of the dorsal veins, where it is intimately
connected with the nerves. This is unsatisfactory:
As it does not necessarily involve increased ca-

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pillars action & without it we cannot explain the phenomena of erection, as the heat, the vermeil colour of the penis &c. Can we deduce any analogy, to warrant us in believing that the veins have an active dilatative power, a faculty of fabricating caloric? None. We find on the contrary, that the largeness of the veins is always passive, and produces instead of a vermeil, a livid, or at most a rosaceous colour, & has a tendency to diminish, rather than increase the caloric, to encumber more than enhance the sensations of a part, as we see in a hand when we hold it pendant, without stimulating the capillaries, while we tug on the veins.

We are compelled to admit a dilatative or attractive power in the penis to invite the blood as the motions of the heart, during erection are known not to be accelerated. To the capillaries then we must recur for an explanation. Nature we know, throughout the whole of her harmonious circle, performs with every one of her elementary structures, operations virtually the same. Let me briefly examine them, throughout

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the system the functions of the capillaries & see if
there be any analogy, in their common action with
erection. Intestines are where between the arteries
& veins, the seat of Inflammation, of the degeneration
of the blood & calcification, of the secretion of some & the
elimination of other fluids, we are naturally desirous
of becoming acquainted with their structure, which
is evidently possessed with inherent powers, to which
the other systems are strangers: But here an alchemical
research is set at defiance by their minuteness. By their
functions, & by analogy alone can we arrive at any
ideas of their structure. By function, in the manner
in which they procure the circulation of Blood in the
veins in a normal state, & by the provocations of Inflam-
mation when abnormally excited; And by analogy the
resemblance of office, in the circulation to the action
of the heart. When we hold a hand to the fire, we
perceive the capillaries instantly to dilate themselves,
to elevate the skin by eliciting more blood to the part &
to accelerate the motion of the Blood in the veins.
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Hodgson has shown that the anastomosing branches, begin first to dilate themselves, at their capillary extremities, & in consequence of the unusual action of these last, an unusual degree of heat, is often excited in the limb. In animals whose horns have an annual growth, the capillaries of the part become excited & cause the arteries leading them, to enlarge without any increase in the propulsive power of the heart. The bad consequences of Inflammation here, do not result, for the arteries are relieved by the freedom of the secretion, which produces the rapid growth of the horns. The same thing occurs in the uterus during gestation, & the arteries here are relieved, by ministering to the necessities of the foetus. Many instances might be adduced, a few will answer my purpose: Every irritation we know to have the effect of accumulating blood, & to what agency can this be attributed but capillary action. Mental Influence we also see, can modify capillary action, as in the phenomena of blushing, the suffusion of shame or the rage of Passion. When the brain gives itself up to it

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noble functions, who is there that knows himself that is not aware of the determination of blood to it & does not feel its vivifying influence, to which the capillaries of the face & neck bear frequent witness. The influence which the capillaries exert in venous circulation is susceptible of many illustrations.

In wounds which involve only the capillaries, the blood does not flow per saltum, but trickles as it were in a sheet. This shows the influence of the heart there is nearly null, as we should presume it would be, when the blood is divided into so many channels:

The capillaries here exert the influence of another heart in giving the blood a gentle motion at the bottom of the column (or in the roots of the veins,) which becomes a considerable momentum when the blood is collected into a narrow channel in the vense cavae. The contractility of the veins may assist, but would not suffice to circulate the blood: And in the liver we perceive the contractility of the portal veins carrying the blood, is directly opposed to that of the vense cavae hepaticae which return it.

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In the Sinuses of the Brain, the contractility of the venous structure, must be extremely feeble: How with Mr. Brownians we must believe the capillaries give the blood a new impetus, which enables it to reach the heart.

How can we account for the circulation in some of the lower animals, which have perfect circulatory circles though, deprived of a central organ, otherwise than by supposing that the capillaries move the blood through the vessels from tissue to tissue. How else can we account for the accumulations of blood which take place in chronic Inflammations, & shift from organ to organ, but by the respective excitations of the parts affected; We find hearts only in animals where the blood has to pass a great way without the aid of capillary vessels. In the more perfect plants, the fluids must be conducted in the same way.

It may be said that if we attribute this heart like action to the capillaries, we should prove them to have the same structure. Their minuteness renders this impossible. We know they possess the same lining membrane as the heart, for it is continued

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through into the veins: The Yellow ligament of the arteries, which takes its origin from the heart, terminates at the capillaries, for it is not found in the veins, offering therefore no resistance to the dilatation of the capillaries, or of the heart. Cuvier has declared that in the Elephant, he could perceive the arteries to contain more fibres & grow more red & muscular as they approached their capillary extremities, thus giving one mode of accounting for capillary action. We all know the power of muscular fibres. We have seen what astonishing force a small quantity can exert in the common Skipper, enabling it to spring many times its length. Anatomists have shown that the capillaries are rich in the nerves of organic life: The arteries seem to serve as conductors of the nerves to these vessels. Like the ventricles of the heart, the capillaries communicate on one side with the arteries, on the other with the veins, for the auricles are but dilated veins united to the pericardium. We may also infer that like the ventricles they have their vasa vasorum, or some

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equivolent mode of nutrition. This may perhaps excite a smile, but closer investigation will I think show, that the difference between the capillaries and the heart is not very great, when we view their respective actions, with regard to their difference in magnitude. We know that Dr. Hunter injected the blood vessels of a bee, and there would hardly be reason, in denying them to be arteries & veins, because they were not so large as those of the man. The same process of reasoning then, which shall explain the actions of the heart, will suffice for those of the Capillaries. We well know what influence the passions exert over the heart and we can as readily conceive, how the mental affections should act on the Capillaries, so as to produce blushing in the face or erection in the penis, as both are endowed with nerves from the same system. From what I have said I think it is very evident, that the capillaries will form a proper "Erectile tissue, whenever they shall have a disposition analogous to that in the penis, Clitoris &c. That, is, surrounded by a

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structure that will readily dilate on an increase of organic action within. In the spongy heads of the long bones, there is a cancellated structure, over which ramify blood vessels. But this is not an erectile tissue. For when its vessels are abnormally excited, it is unable to dilate, its organic sensibility is exalted which reacts upon the brain & pain is produced. But in the penis, we see the rise of the organ, to vary constantly with the organic sensibility of the part, between its diminutiveness when exposed for a long time to the chill of a cold bath, to its evolution in a state of excitement.

It may be said, that by mixing its action in the capillaries, it will have no claim to an arrangement, as a tissue: But erection is the peculiar normal action of the part to which all others are subordinate, & for purposes highly important to the animal economy. The Capillaries are only the affective agents. The same objection might be urged against the glandular system, in which the capillaries are the only instruments of action, and we see that they have individually the power of secreting lymph &c.

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Did we not restrict ourselves in this way, we might go on, ad infinitum, until we should see, in the contraction of all our muscles, nothing but the chemical attraction of their component globules & the elasticity of the tissue which connects them. I will now conceive the stimulus to be applied to the penis which shall cause its erection, be it, natural, mechanical, chemical, or mental. The excitement is said by M. Broussais to be general throughout the capillary system, the Mouth in extreme cases to be dry & parched & vivid sensations to be felt at the epigastrium.

The capillaries of the tissue instantaneously dilate, invite an increased quantity of blood into its structure & generate a considerable quantity of caloric.

The elastic involucre ^{chiefly} expands itself, partly by vascular distension, assisted perhaps by the distension its molecules feel, in consequence of the caloric; the veins as they pass through the ligament become paralyzed by the expansion & permit their dilatable walls within to be distended by the increased action of the capillaries.

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appearance, which the veins have in this tissue, at their origin: And Mr. Chaussier has remarked that the veins have at their origin throughout the system, a dilated appearance, resembling somewhat the erectile tissues: The fleshy part of the finger when the sense of touch resides in a great state of perfection, shows this in an eminent degree. The temporary stimulation over, the elastic ligaments react, facilitate the effusion of the blood through the veins, and the organ regains its former state & degree of sensibility. That the elastic coat may thus react Mr. Shaw has fairly proved.

Having produced by injection the same degree of erection we have in Gonorrhea, he introduced a bougie into the urethra & found it ejected by the elasticity of the ligament with some force. In another experiment he threw into the canal a quantity of water & found it ejected a distance nearly of two yards. A similar mode of action appears to me exist in all the erectile bodies, but to which my limits will not allow me to refer. Phenomena nearly similar have been supposed by Dr. Hays of this City to be developed in

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the erection of the Iris. We well know the great number of capillaries which exist in this part, connected with the ciliary vessels: And we know also that if its proper stimulus light, be applied too vividly, or too long without intermission, that the abnormal irritation which ensues will produce its inflammation, Iritis.

By what other principle than erection can we account for the phenomena, which occur in some of the plants during their fructification. In the Passion flower for instance, the *Passiflora Coerulea*, when it has arrived at a state of maturation, we see the Stamina one by one approach the pistil to deposit on it from their anthers, the fecundating pollen, return to their former position & divide away. If the view I have taken be correct, there is but little difference between the erection of this tissue & the influence of inflammation: Its parts frequently inflamed are most liable to inflammation again, so it is, with this tissue, the more frequently it is excited in action the more subservient is it to stimulation. Let me reverse the picture, & see if common inflammation in-

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-duced in these parts by its ordinary causes is characterised by similar phenomena. Few words will suffice to prove it: In Priapism, & Satyriasis, it most undeniably exists, and in Nymphomania, as is well known has been the case with the notorious Meppolina.

Instances of this last are recorded in which females religiously chaste, & of immaculate character, have exhibited an appearance of disgusting depravity, & it has gone on till it has deteriorated the functions, & jeopardised even the existence of life: Among the lower animals as the cow &c, which like plants, seem to have the power of fecundating - but at one period of the Year, the normal excitement of the genital parts, seems to be a state of regular inflammation, eliciting uncontrollable desires. Habit in the penis, as in other parts under the influence of the nerves exerts her influence; The man accustomed to libidinous indulgences will have upon the least stimulation his rectile system, thrown into a state of excitement. The same principle of action exists in the determination of blood to the haem. st. The

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phlegmatic man unaccustomed to the exercise of his mental faculties, but who tasks his other system inordinately as the stomach, liver &c. will have there all the action developed in fever. In the man of fancy and a reflection on the contrary we often see little such excitement is sufficient to throw all the faculties of his brain into a state of ebullition.

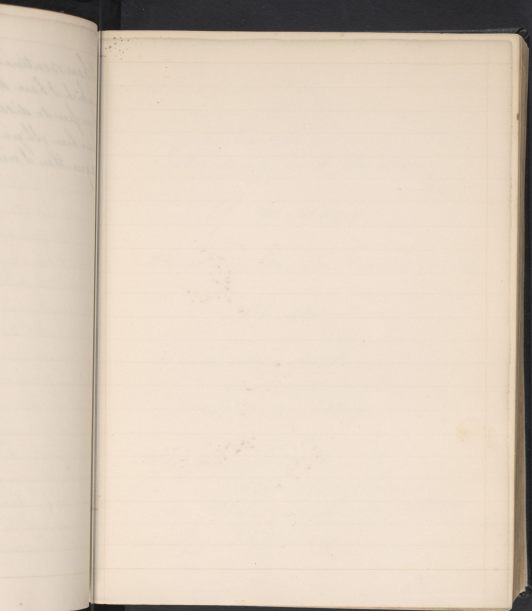
- Of the principle which presides over the excitability of this tissue we know but little & can never know much, till man be able to explain all the secrets of his mysterious Psychology. Whether we locate it with Mr. Gall in the Cerebellum, or with M. Brownpatis in the secretory organs of the Semen we leave the reader but half read, & tis perhaps in vain for man, to carry his abstractions farther.

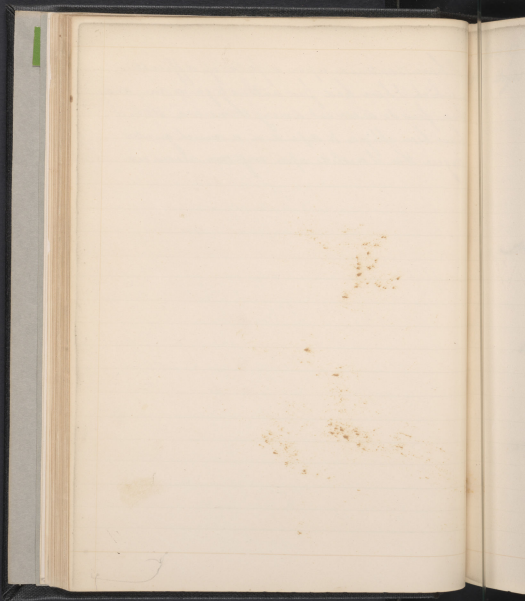
Such then appears to be the phenomena of action in the penis & such as it occurs in the other-erectile bodies, though somewhat modified perhaps, by its location: As interesting perhaps in their nature, as any which appear in the system, when viewed as they should be in a philosophical light.

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I have ventured upon a field of difficulties,
in which I have had few authors to guide me, and
those few so dissident among themselves, that I
have been obliged to depend in a much greater
degree than I wished upon my own resources.

I have written upon a piece of paper
which I have had for some time
and I have written upon it
the words which I have written
upon the paper of the same
color.





1829
Sept 7th Edmund Pay

On the
Anatomy and Functions
Of the Skin

Presented to the Medical Faculty
Of the

University of Pennsylvania

Sept. 7th 1829

For the Degree of
Doctor of Medicine
By William H. Smith
Of Virginia

Jun 17
to 18